MULTISCALE ASYMPTOTICS AND ANALYSIS FOR ATMOSPHERIC FLOW MODELS WITH MOISTURE

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Model reductions in meteorology by scale analysis are inevitable and therefore have a long history in meteorology. The key technique for a systematic study of complex processes involving the interaction of phenomena on different length and time scales is multiple scales asymptotics. Due to their major contribution to the energy transport of particular interest are hot towers, which are large cumulonimbus clouds that live on small horizontal scales. In comparison to existing studies we not only incorporate moisture into the model via balance equations for water vapor, cloud water and rain, but also refine the thermodynamics by taking into account the different gas constants and heat capacities for water in contrast to dry air. This refined setting is demonstrated to be essential by leading to different force balances.

These deep convective clouds furthermore constitute the building blocks of intermediate scale convective storms, which we study in a next step by incorporating the setting of organised convection into the multiscale approach. This requires systematic averaging procedures, allowing to quantify the modulation of the larger scale flow by the moisture processes in the small scale regions. This work is joint work with R. Klein.

While the just described multiscale asymptotics are purely formal, in collaboration with R. Klein, J. Li and E. Titi, we also proceed further in the rigorous analysis of the atmospheric flow models with moisture and phase transitions. We study the global existence and uniqueness of solutions for the moisture balance equations coupled to the thermodynamic equation building the basis for the above expansions. In a first step we assume the flow field to be given and then extend the analysis to the refined moisture model coupled to the primitive equations.